Minimalism in Designing User Interface of the Online Platform "Higher School Mathematics Teacher"

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Abstract. The article addresses the issue of minimalism in User Interface (UI) design of online courses. The paper debates the latest researches related to UI design, the quality of which influences the success of educational platforms. The analysis, which we carried out, allowed us to focus on such minimalism criteria of online courses that provide students' satisfaction with online education. The research considers the design tools that are used to achieve minimalistic UI of mathematical and methodical courses on the platform "Higher School Mathematics Teacher". The article discusses the creation of a minimalistic UI model and web tools search to develop it. During the survey, the answers, which were given by 203 volunteers, who became the first users of platform courses, allowed determining the directions of interface improvement on the platform "Higher School Mathematics Teacher. The received average estimate confirmed the interface minimalism of the online courses published on the platform "Higher School Mathematics Teacher".

Keywords: User Interface of online courses, minimalism principles, design tools, Web design elements: accordions, tabs, sliders.

1 Introduction

1.1 Problem statement

Before creating a website that will correspond to the user's needs, the question of developing a web page arises among specialists. Their minimalism is among the latest trends that web page design experts consider. Moreover, studying strategies that influence User Interface (UI) developments, studios Acodez [1], Nielsen Norman Group [2], WebsiteBuildErexpert [3], TheNextWeb [4] indicate that minimalism is

something users prefer first. Experts warn that involving an excessive number of technologies decreases the chances to involve customers to the web product. Mathematics teacher is a serious demanding client who is well oriented in the modern web design market. That is why the issue of involving minimalism in designing UI of the online platform "Higher School Mathematics Teacher" [5] is actual, following which concept [6], represents online mathematics and methodical courses, that are used by both mathematics teachers and students who master the pedagogical profession.

1.2 Analysis of recent research papers and publications

The conclusions in the research made by Ahmad Tajudin Baharin et al. [7] confirm that interface design of online courses is as important as the content and educational method choice. While analyzing UI design directions, the scientists proved that its quality influences the success of a separate course and an educational platform as a whole.

Nowadays UI designers point out minimalism as one of the main web design trends that are used while developing structures and content of the online course. Scientists also discuss this trend in their researches. Colleen Carraher Wolverton and Brandi N. Guidry Hollier [8] describe the survey among university teachers concerning the involvement of a minimalistic approach to the course development. The authors of the article believe that it is necessary to use fewer technologies, use and simplify the education, necessary for teaching an online course, emphasizing that the course should be simple. Somayeh Mehrizi Sani and Yeganeh Keyvan Shokooh [9] highlight that minimalism with unnecessary aspects elimination and visual elements organization leads to the audience confusion decrease and increase of efficient interaction with the web site. In order to determine and prove the factors that influence teachers' satisfaction with their studies on the Internet Doris U. Bolliger and Oksana Wasilik [10] developed a web survey that they used to estimate the acquired teachers' satisfaction in the context of online educational environment. While describing respondents' answers the scientists pointed out that minimalism principle use allows making an online course graphically simple. In its turn, university teachers who worked with the course indicated that purely efficient design helps them not to get distracted by the presentation during the course. While studying minimalistic documentation strategies and their successful use to create short videos, Ehren Helmut Pflugfelder [11] offered an instruction considering minimalism in web applications. Ard W. Lazonder [12] also points out the importance of developing such instructions and specifies that in order to create a minimalistic interface, web developer has to post the elements strictly showing only those which have the highest importance and do not distract users from the important part. While estimating the positive and negative interface influence of online developments on educational process Jose María del Campo et al. [13] carried out a research User eXperience (UX) using a qualitative analysis of students' surveys studying the level of their satisfaction with web page use. Kristen Suzanne Betts [14], Doris U. Bolliger and Trey Martindale [15], Judith V. Boettcher [16], Diane M. Bender et al. [17], Doris U. Bolliger and Oksana Wasilik [10] studied the factors to determine students' satisfaction with online development. Among the factors that explain students' satisfaction with online courses, scientists point out: intuitively clear

navigation system and free space on course pages, page download speed on the platform, easy navigation and easy access to the necessary educational content, involving an insignificant number of interactive web design elements.

Therefore, the analysis of the above-mentioned papers helped to determine the goal of this research. It became the search for web tools to develop a minimalistic UI model, the use of which allows making online courses on the platform "Higher school Mathematics Teacher" graphically simple and accessible for users.

2 Method

When we studied the question of the minimalistic UI use while developing UI online courses we analyzed several Mathematics courses published on the educational platforms Prometheus [18], Edera [19], EDUGET[20], iLearn [21], Coursera [22] and The Open University [23].

While analyzing the courses of the above-mentioned platforms we considered the User Interface correspondence of these courses to the modern web design trends and determined in Table 1 the types of interactive elements that are the most used to implement the minimalism concept.

The Deductive Approach to Content Analysis of Mathematics courses helped to choose the popular elements that are used in web design to achieve minimalism. The navigation implementation in most analyzed courses is carried out using accordions that enable not to overload users with minor information having access to the educational content. Besides, on Prometheus [18], Edera [19], EDUGET [20] and The Open University [23] platforms, tab navigation is used. In the design of educational online courses published on the platforms Edera [19], iLearn [21] and Coursera [22] sliders are used to systematize text or graphic information.

Therefore, the results of the carried analysis ensured the use description of accordions, tabs, and sliders.

2.1 "Accordion" element use

The graphic interface element "accordion" is used when it is necessary to structure the content. It looks like a vertically or horizontally built set of elements that have a text mark or draft and the main part. Every element can have two states – hidden or open. These states are responsible for the visual feature of the main element part. The change of these states is implemented by clicking on the text mark or draft. Usually, at a certain point, only one "accordion" element is active, it deactivates when you choose another element or double click on the current element. While using "accordions" you can get a convenient view of the complex elements' hierarchy, as this interface element can fold one into another. Therefore, "accordions" use in UI design enables to follow minimalism postulates and not to overload users with minor information.

"Accordions" integration in the online course allows implementing a convenient structural system of content compilation, since, usually, an online course includes sections, topics, subtopics, and subsections. "Accordions" use enables the participants

to navigate easily through the online course, choosing one or another element of its structure.

Table 1. Use of the most used interactive elements to implement the minimalism concept in mathematical courses on educational platforms.

Online courses	UI minimalism implementation tools		
	"Accordion" element use	**Slider use**	**Tab use**
Data analysis and statistic conclusion using R language [24]	Is not used	Is not used	For the content division of every course chapter into sections
Algorithms development and analysis [25]	Is not used	Is not used	For the content division of every course chapter into sections
Mathematics: Arithmetic, equations and inequalities [26]	For course content structuring and navigation implementation	For educational material presentation	For the content division of every course chapter into sections
Solid geometry [27]	For navigation implementation	Is not used	For course navigation implementation
Derivative and integral. Combinatorics and probability [28]	For course content structuring and navigation implementation	Is not used	For course navigation implementation
Mathematics. Simple [29]	Is not used	For text information systematization	Is not used
Matrix Algebra for Engineers [30]	For course content forming and navigation implementation	For educational material presentation	Is not used
Advanced Linear Models for Data Science 1: Least Squares [31]	For course content navigation implementation	For theoretical material presentation	Is not used
Mathematics for Machine Learning: Linear Algebra [32]	For course content navigation implementation	For graphic information systematization	Is not used
Mathematics for science and technology [33]	For course content structuring	Is not used	For navigation implementation through course sections
An introduction to complex numbers [34]	For forming structured course content and navigation implementation	For text information systematization	For navigation implementation through course sections
Using numbers and handling data [35]	For forming structured course content and navigation implementation	For theoretical material presentation	For navigation implementation through course sections

There are several approaches to create "accordions". Let us point out the main ones.

1. “Accordion” program implementation through cascading style sheets (CSS) using script programming language JavaScript. This approach implies the content structure creation in HTML format, CSS stylization and interactivity implementation using jQuery library. Nowadays, “accordion” implementation is simplified because it has already been created and integrated into a big number of front-end frameworks such as React.js, Angular, Vue.js, Bootstrap, etc. It enables to create “accordions” without writing JavaScript code.
2. Using program libraries of front-end frameworks. If the front-end framework is used while creating a platform for online courses, there is a possibility to use ready libraries for “accordions” implementation. For instance, there is Gentelella library for Yii2 framework, Material Dashboard library for Laravel framework.
3. Using “Content Management Systems” (CMS) plugins. For instance, if CMS systems are used to create platforms for online courses, it is possible to connect the ready plugins of this system. For example, for CMS WordPress there are plugins to create Accordions Tables, Accordion FAQ, Easy Accordion, etc. On the platform “Higher School Mathematics Teacher” [5] we used the plugin “Responsive Accordion and Collapse”, that includes a set of the main tools to create accordions. The main advantages of using plugins are flexible settings of accordion look, ensuring convenient data entry and content editing, published in accordion sections.

2.2 Sliders use on pages of educational online courses

Slider is a web design element that includes a block of a certain length, the main function of which is a consistent image (or other content) change.

Using sliders on pages of educational online courses allows providing users with the necessary information without scrolling the page. Moreover, sliders enable us to save space and not to visually overload the web page.

In general, sliders have a minimalistic design and consist of the following elements: navigation tools, a screen, and markers with the information on the slide number. Some sliders can contain miniatures of other slides, a timer with the slide change time and they can predict a possibility to pause when you hover the cursor over the current slide.

Slide change takes place in the automatic, manual and mixed mode. The mode choice depends on the functional slider’s purpose within a particular online course.

Sliders are implemented using JavaScript technologies. Each of them is based on HTML-code. In most cases, constructions of such types are created using jQuery library that includes a significant number of standardized objects to create sliders of different types, forms, and content. In functions that are responsible for the slider’s work, slides’ turning speed is indicated, presentation conditions of previous/ following slides are given, and visual slides’ presentation and turning effects are set. At the same time, HTML-code is responsible for slides “bringing” in the necessary web page place, CSS – for the slider look, JavaScript – directly for the slider’s work, in particular, jQuery library functions.

While integrating sliders on the pages of “Higher School Mathematics Teacher” platform to represent educational content we use the manual mode of slides change. Sliders are created using WordPress plugin “Elementor” and are completely adaptive.

Nowadays there are plenty of plugins to create sliders, in particular, MetaSlider, Master Slider, Slider Pro, etc.

2.3 Using tabs as the best navigation option

One of the most popular elements that are used in web design to achieve fast and interactive content presentation is tabs. Tabs are web interface element that consists of a headline and hidden content that becomes available referring to the headline.

Tabs are used to divide the content into sections. It facilitates saving space on the screen and simplifies users' access to the necessary content. The content should be divided into parts in order to look logical, expected and clear for users.

Tabs use as a navigation system on pages of online courses is relevant when there are from 2 to 9 categories of educational content that can fit in one line. For online courses of the platform "Higher School Mathematics Teacher", which includes from 3 to 6 sections, the tabs use is one of the best navigation options.

When integrating tabs on web pages it is necessary to consider the fact that the number of categories should not be often changed, the text on the tabs should be logical and substantial. The chosen tab should stand out, defining the user's location now. It is not recommended to include the navigation with tabs in the design in case users need to have a simultaneous content comparison, as tabs navigation will overload the memory, significantly increasing cognitive load.

While using tabs it is necessary to avoid overloading web pages during windows changing, as it significantly slows down the navigation between tabs. Distant content downloading using Ajax can be one of the options that are used for the dynamic information published on the external server. In this case, it is relevant to use JavaScript.

The carried analysis using interactive elements helped us to develop a minimalistic UI model of online courses on the platform "Higher School Mathematics Teacher" (Figure 1).

3 Results

In order to carry out the User Interface relevance level analysis of online courses [43-46] published on the platform "Higher School Mathematics Teacher" [5] to the minimalistic web design principles, we held a survey among platform users. Respondents were offered to go through the survey using the form developed through Survio service [36], which enables a survey creation, their integration on web pages and received data analysis. In order to get a greater number of answers, we posted the created survey on the forum of the platform "Higher School Mathematics Teacher" through iFrame implementation.

203 respondents took part in the survey. We were interested in teachers' and students' opinion who became the first platform users. These were the representatives from Donbas State Engineering Academy, Donbas National Academy of Civil Engineering and Architecture, Institute of chemical technologies of Dahl East Ukrainian National University (the town of Rubizhne), Kryvyi Rih State Pedagogical

University. We offered them to range the correspondence criteria of the developed online courses interface to the minimalism principles on a scale from 1 to 5 where 1 is a minimal parameter estimate and 5 is maximal. Volunteers' responses analysis is represented below.

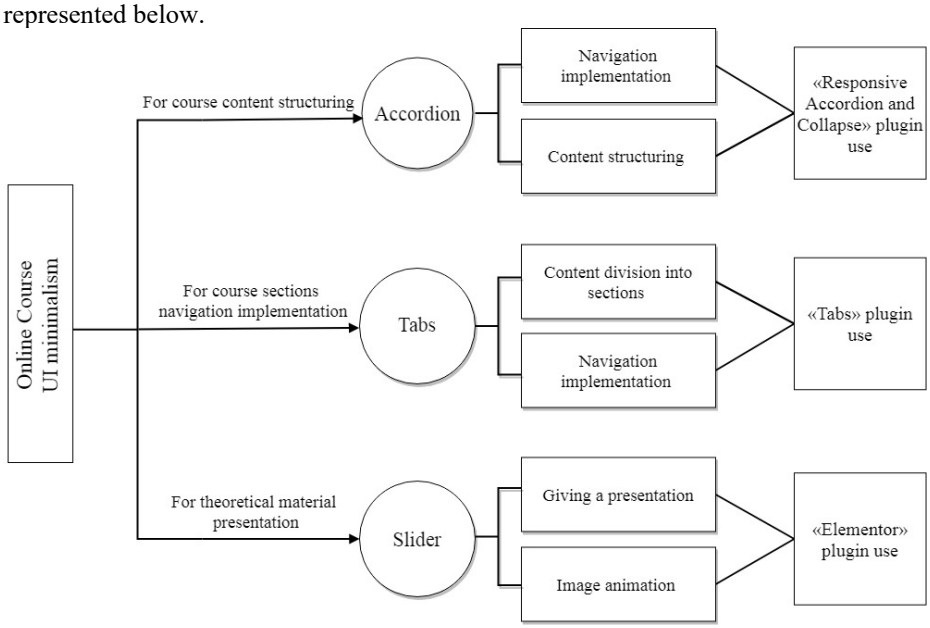

Fig. 1. Minimalistic UI model of online courses on the platform "Higher School Mathematics Teacher".

So, according to the survey results (Figure 2), 40,9% of respondents totally agree with the fact that the navigation system on course pages is simple and intuitively clear, 27,3% agree, 20,5 % rather agree, 9,1% rather do not agree with this statement and 2,3% of respondents believe that the navigation system is complicated and unclear. Besides, in most platform users' opinion, the elements on course pages are strictly structured (Figure 3).

The survey results on page download speed on the platform are the same. 43,5% of respondents chose the variant "excellent", 34,8% – "good", 10,8% think that download speed is satisfactory, 8,7% – sufficient and 2,2% pointed out that pages download too long.

The survey results of free space on course pages (Figure 4) showed that practically a quarter of the respondents do not agree with this statement. As free space is one of the most important principles of minimalistic design, the received result indicates the necessity to improve the interface following this direction.

According to the navigation ease on course pages, it is pointed out (Figure 5) that 42,9% of respondents easily navigate on the page, 28,6% chose the variant "good", 16,7% think that navigation ease is satisfactory, 9,5% –sufficient, and 2,4% highlighted that it is quite difficult to navigate on the page. Thus, the received answers proved the

absence of users' overload with minor information on the course pages, which is one of the key principles of minimalistic design.

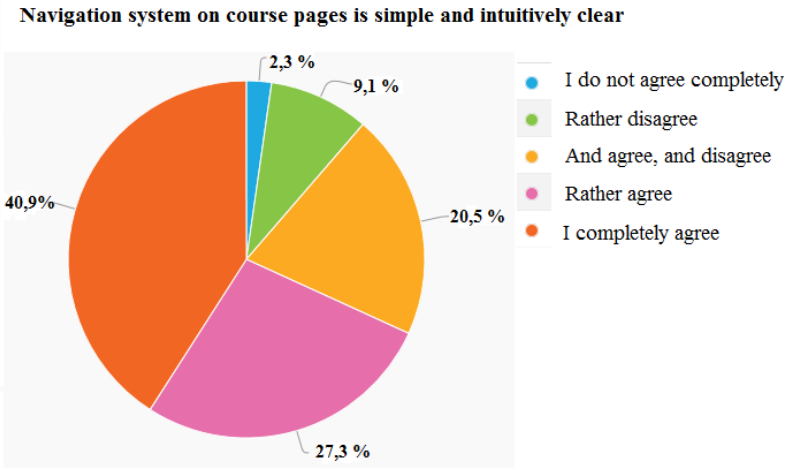

Fig. 2. Ranging respondents' opinion on the navigation system of online courses on the platform.

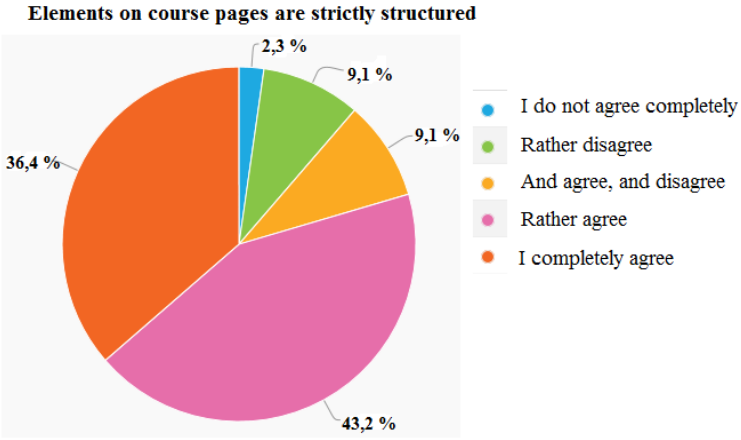

Fig. 3. Ranging platform respondents' opinion on elements ordering on course pages.

While estimating easy access to the necessary educational content during the course, 42,9% of respondents put the mark "excellent", 35,7% – "good", 7,1% – "satisfactory", 11,9% – "sufficient", 2,4% – "unsatisfactory". The results of estimating logic and comprehensibility to represent educational content are practically identical. 88,1% of respondents are satisfied with the content presentation, 11,9 % of respondents believe that logic and comprehensibility do not correspond to their requirements. Also, 76,2 % of respondents confirmed that clear headlines are used on online course pages. 71,8% of users indicated that an insignificant number of interactive elements are present on

course pages,13% rather agree with this statement and 15,2% point out the necessity to improve the pages regarding the involvement of interactive web design elements.

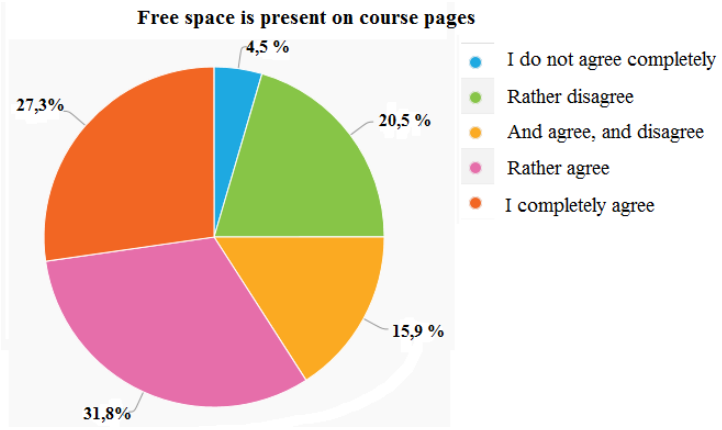

Fig. 4. Ranging respondents' opinion about free space on course pages.

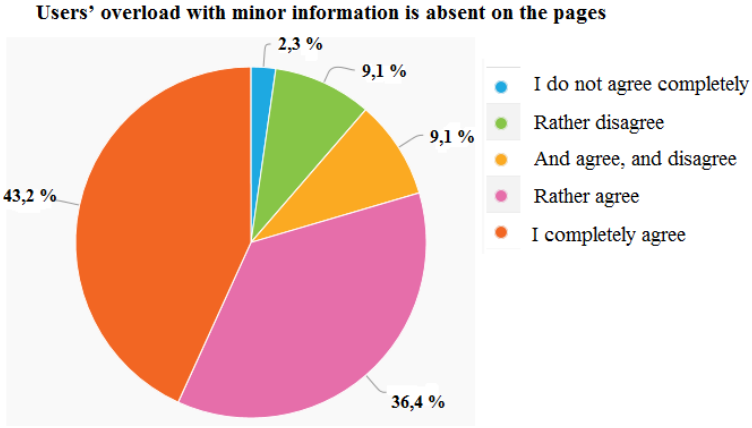

Fig. 5. Ranging respondents' answers on users' overload with minor information.

To verify the internal consistency of the survey results we calculated the Cronbach's Alpha by the formula:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum S_i^2}{S_T^2}\right)$$

where k – the number of criteria included in the survey; S_i – the mean-squared departure of the i-th criterion (i=1,…, k); S_T – the mean-squared departure of total indicators for all survey criteria.

As a result of the calculation https://drive.google.com/open?id=1HK5X0aJUNdC7g9ytSgrwRpVzHIo5kvNt, we got the value α = 0,713, indicating a sufficient level of internal consistency.

Following the survey results, an average estimate of the given criteria implementation quality was calculated and is represented in table 2.

Table 2. The average estimation of minimalism criteria implementation quality on the online platform "Higher School Mathematics Teacher".

Criterion	Average estimation
1. Easy, intuitively clear navigation system	3,97
2. Strictly structured elements	4,03
3. Page download speed	4,03
4. Free space on the page	3,68
5. Easy navigation on the page	4,09
6. Absence of users' overload with minor information	4,05
7. Easy access to the necessary educational content	4,07
8. Logic and comprehensibility of content presentation	4,1
9. Headlines clarity	4,02
10. An insignificant number of interactive elements on the page	3,88
Total average estimation	3, 992

After getting a total average estimate of 3,992, we conclude that the interface of online courses published on the platform "Higher School Mathematics Teacher", can be called minimalistic. Additional improvement requires sticking to the criteria on free space and involving an insignificant number of interactive elements on course pages.

4 Discussion

Hans van der Meij and John M. Carroll [37] defend the minimalistic approach as a better method to develop education and provide information. Hartmut Obendorf [38] emphasized that minimalism becomes an important tool that helps to visualize the simple thing. The scientist defined minimalism types for the interaction design of educational process participants, and he discusses the tools for different forms of design minimization. Papia Bawa [39] highlighted the minimalism advantages from a technical point of view as a faster page download and better compatibility using screens of different sizes. Therefore, scientists' research proved our opinion about the actuality of researching minimalism in designing user interface on the online platform "Higher School Mathematics Teacher".

The opinion given by UI-designers, back-end developers of studios Turum-burum [40], University Teaching & Learning Center [41], Neo Blog [42], Campus Technology [16] and the Deductive Approach to Content Analysis of mathematics courses on well-known online platforms [18-23] described the implementation of accordions, tabs, and sliders that are used in web design to achieve minimalism. The analysis of the indicated web design elements helped to develop the model (Figure 1), during the creation of which we concentrated our attention on such UI minimalism criteria of educational online courses as free space on course pages, minor information on course pages, intuitively clear navigation system and page download speed. During the platform

users' survey, we concentrated on the verification of how the offered criteria are followed on the pages of the courses that are published on the platform.

Based on the carried research we developed a minimalistic UI model of the platform online courses that reflects: elements providing minimalism, elements functions that allow ensuring minimalistic UI criteria, plugins to create web design elements. Model functioning ensures navigation implementation on course pages, content structuring with its division into sections, giving presentation and image animation.

5 Conclusions

Resource and scientific research analysis proves the necessity to follow minimalism principles while developing an online course of the platform "Higher School Mathematics Teacher". We relied on the resource and scientific research analysis that gives recommendations on the minimalism criteria development and offered a group of criteria that ensure easy understanding of the course material, do not overload users with minor information, and make navigation on course pages easy and accessible.

We offered to range the developed course interface following the criteria of minimalism principles to estimate UI minimalism of platform educational online courses. After getting a total average estimate of 3,992 on UI minimalism criteria implementation quality from the respondents, we concluded that the developed course interface on the platform "Higher School Mathematics Teacher" can be considered minimalistic. The improvement of the received average result is possible on condition that the interface, which ensures sufficient free space on course pages according to the developed a minimalistic UI model of online courses on the platform "Higher School Mathematics Teacher", is improved. Therefore, we connect further research with the User Interface platform improvement according to the minimalism principle and quality typography use, as the latter one improves material readability, increases the information perception level, influences educational material learning level.

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